CLAIMS

1. A process for the production of a starch that is pharmaceutically acceptable, especially for parenteral administration, for example by means of injection, to a mammal, especially a human, which comprises

a) starting from starch in solid form, especially particles, for example granules, and with an amylopectin content in excess of 85 percent by weight, expressed as dry weight of starch,

b) subjecting said solid starch to washing(s) under conditions such that proteins, lipids and endotoxins surface-localized on the starch are dissolved whilst the starch remains undissolved, and separating the starch from the dissolved material,

c) causing the washed starch obtained from step b) to dissolve in an aqueous medium, and

d) subjecting the starch solution to a molecular weight reduction by shearing such that a molecular weight distribution is obtained in which at least 80 percent by weight of the material lies within the range of 10-10000 kDa.

2. A process according to claim 1, which comprises removing residual water-soluble proteins from the starch.

3. A process according to claim 2, which comprises removing said water-soluble proteins after performing step d) to reduce the molecular weight of the starch.

4. A process according to claim 2, which comprises removing said water-soluble proteins before performing step d) to reduce the molecular weight of the starch.

5. A process according to claim 1, in which step a) is performed using starch with an amylopectin content in excess of 95 percent by weight, preferably in excess of 98 percent by weight, expressed as dry weight of starch.

6. A process according to claim 5, in which said starch is waxy maize starch, preferably native or acid-hydrolyzed

starch.

7. A process according to claim 1, in which step a) is undertaken using starch particles with an average diameter in the range 5-25 μm, based on weight distribution.

8. A process according to claim 1, in which the washing in step b) is performed under alkaline conditions, preferably using sodium hydroxide as alkali, and in one or more stages.

9. A process according to claim 8, in which the washing or washings in step b) is/are performed at a pH value in the range of 11-14, preferably in two stages with a first stage using aqueous alkali solution at pH 11.5-13 and a second stage which is performed under conditions in which the input pH value in the aqueous phase is in the range of 12.5-13.5.

10. A process according to claim 9, in which the washing comprises a stage with an aqueous alkaline solution for dissolving water-soluble proteins, lipids and endotoxins and a stage with an aqueous solvent with the ability to dissolve zein for dissolving more sparingly soluble proteins.

11. A process according to claim 10, in which the solvent with the ability to dissolve zein is selected from aqueous solutions of monovalent or divalent alcohols and ketones, preferably alkanols or alkylene glycols containing a total of up to 4 carbon atoms or dialkyl ketones with a total of up to 5 carbon atoms.

12. A process according to claim 11, in which the solvent is selected from aqueous solutions of ethanol, isopropanol, ethylene glycol, propylene glycol and acetone.

13. A process according to claim 12, in which the solvent is an aqueous ethanol solution.

14. A process according to claim 1, in which the dissolution in step c) is carried out so that a starch solution is obtained with a concentration in the range of

1-25%.

15. A process according to claim 1, in which the dissolution in step c) is carried out in water acceptable for production of starch for parenteral use, preferably water for injection.

16. A process according to claim 1, in which the shearing in step d) is carried out so that a molecular weight distribution is obtained in which at least 80% of the material is in the range of 100-4000 kDa, preferably 200-1000 kDa, especially 300-600 kDa.

17. A process according to claim 1, in which the shearing in step d) is carried out in a high-pressure homogenizer.

18. A process according to claim 17, in which the shearing is carried out at a pressure in excess of 1200 bar, preferably in the range 1200-1500 bar.

19. A process according to claim 2, in which said removal of residual water-soluble proteins from the starch is performed by subjecting the starch solution to ion exchange chromatography, preferably anion exchange chromatography.

20. A process according to claim 2, in which said removal of residual water-soluble proteins from the starch is performed by electrophoresis.

21. A process according to claim 1, in which prior to the washings in step b) non-starch material is removed from the starting starch, preferably by sieving and/or sedimentation.

22. A process according to claim 21, in which material that is larger than the starch particles is removed by wet sieving and material that is smaller than the starch particles is removed by sedimentation.

23. A process according to claim 21, in which non-starch material that is larger than 40 µm is removed, and preferably also non-starch material that is smaller than 5 µm.

24. A process according to claim 1, in which prior to the shearing in step d) any residual particulate non-starch material is removed by filtering of the solution, preferably through a 20 µm filter and optionally thereafter through a 0.5 µm filter.

25. A process according to claim 1, in which the solution obtained from the shearing in step d) is subjected to filtering to remove any particulate contamination generated during said shearing, the filtration preferably being carried out with a 5 µm filter.

26. A process according to claim 2, in which, after the removal of residual water-soluble proteins from the starch, filtering is carried out, preferably through a 5 µm pre-filter and a 0.5 µm filter, to remove any particulate contamination.

27. A process according to claim 19, in which at least 0.4, preferably at least 0.8, ml of sedimented bed volume of ion exchange material per gram of starch is used in the ion exchange chromatography.

28. A process according to claim 1, in which the purified starch is subjected to a final drying stage, preferably by means of spray drying.

29. A process according to claim 1, in which the washing in step b) comprises washing with a thioglycolate solution to remove sparingly soluble proteins.

30. A pharmaceutically acceptable starch, especially for parenteral administration, preferably by way of injection, to a mammal, especially a human, which

a) has an amylopectin content in excess of 85 percent by weight, in which the molecular weight of said amylopectin has been reduced, preferably by shearing so that at least 80 percent by weight of the material lies within the range of 10-10, 000 kDa,

b) has a purity of at most 50 µg amino acid nitrogen per gram dry weight of starch, preferably at most 20 µg,

more preferably at most 10 µg, and most preferably at most 5 µg, amino acid nitrogen per gram dry weight of starch,

c) can be dissolved in a concentration exceeding 25 percent by weight in water.

31. A pharmaceutically acceptable starch, especially for parenteral administration, preferably by way of injection, to a mammal, especially a human, which

a) has an amylopectin content in excess of 85 percent by weight, in which the molecular weight of said amylopectin has been reduced, preferably by shearing so that at least 80 percent by weight of the material lies within the range of 10-10000 kDa,

b) has a purity of at most 50 µg amino acid nitrogen per gram dry weight of starch, preferably at most 20 µg amino acid nitrogen, more preferably at most 10 µg, and most preferably at most 5 µg amino acid nitrogen per gram dry weight of starch,

c) lacks covalently bonded additional chemical groups of the type that occur in hydroxyethyl starch.

32. A starch according to any one of claims 30 and 31, which exhibits the ability to gel in vitro.

33. A starch according to claim 31, which exhibits the ability to form microparticles in an emulsion system, especially a two-phase aqueous system.

34. A starch according to claim 31, which has an endotoxin content of less than 25 EU/g and contains fewer than 100 microorganisms per gram.

35. A starch according to claim 31, which is obtainable by means of a process according to claim 1.

36. A starch according to claim 31 in which said molecular weight of the amylopectin is within the range of 100 - 4000 kDa, preferably 200 - 1000 kDa and more preferably 300 - 600 kDa.

37. A starch according to claim 31 which can be dissolved in water in a concentration exceeding 30%,

preferably exceeding 40%, and more preferably exceeding 45%, by weight.

38. A starch according to claim 31, which remains in solution at a temperature of at most 60°C, preferably 20-45°C, especially 30-37°C, for a period sufficiently long to allow combining with a substance that is temperature sensitive and/or unstable in organic solvents, especially a protein.

39. A starch according to claim 38, wherein said combining is performed at conditions which are able to retain the bioactivity of said substance.

40. A starch according to claim 31, which when dissolved in water solidifies at a temperature of 1-55°C, especially 4-37°C.

41. A starch according to claim 40, which solidifies when exposed to an initial temperature of 1-10°C, especially about 4°C, and subsequently to a temperature of 20-55°C, preferably 25-40°C, especially about 37°C.

42. Microparticles based on starch as a carrier for a biologically active substance, especially for parenteral administration, preferably by way of injection, to a mammal, especially a human, in which said starch is the starch as defined in claim 31.

43. Microparticles according to claim 42, which have a mean particle diameter in the range of 10-200 µm, preferably 20-100 µm, especially 20-80 µm.

44. Microparticles according to any one of claim 42, which exhibit the ability to be dissolved by enzymatic action in vitro or eliminated from biological tissue in vivo.

45. Microparticles according to any one of claim 42, in which the biologically active substance is a protein.